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FORM PTO-1390 (REV 12-29-99)

U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER: INA-PT049 (3284-18-US)

U.S. APPLICATION NO. (If known, see 37 CFR 1.5): 09/763980 Not Yet Known

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/EP99/05885	8/11/1999	8/29/1998

TITLE OF INVENTION: DIFFERENTIAL FOR A MOTOR VEHICLE

APPLICANT(S) FOR DO/EO/US: Jacob et al.

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [x] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. [x] This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. [ ] A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. [x] A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. [x] is transmitted herewith (required only if not transmitted by the International Bureau).
   b. [ ] has been transmitted by the International Bureau.
   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US).
6. [x] A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. [ ] Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. [ ] are transmitted herewith (required only if not transmitted by the International Bureau).
   b. [ ] have been transmitted by the International Bureau.
   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [ ] have not been made and will not be made.
8. [ ] A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. [x] An unsigned oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. [x] A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern document(s) or information included:

11. [x] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. [x] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. [ ] A FIRST preliminary amendment.
    [ ] A SECOND or SUBSEQUENT preliminary amendment.
14. [x] A substitute specification which incorporates Annexes to International Preliminary Examination Report.
15. [ ] A change of power of attorney and/or address letter.
16. [x] Other items or information:
    Application Data Sheet,
    Face page of PCT/EP99/05885 International Publication.
    EXAMINATION IS TO BE BASED ON SUBSTITUTE SPECIFICATION which incorporates I.P.E.A. Annexes, per Amendment referenced in Declaration.

U.S. APPLICATION NO (if known, see 37 CFR 1.5)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
Not Yet Known 09/763980	PCT/EP99/05885	INA-PT049 (3284-18-US)

17. [X] The following fees are submitted:

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :

Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$1,000.00**

International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$860.00**

International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO **$710.00**

International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$690.00**

International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) **$100.00**

				CALCULATIONS	PTO USE ONLY
ENTER APPROPRIATE BASIC FEE AMOUNT =				$ 860	
Surcharge of **$130.00** for furnishing the oath or declaration later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(e)).				$	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	7 - 20 =	0	X **$18.00**	$ 0	
Independent claims	1 - 3 =	0	X **$80.00**	$ 0	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)		0	+ **$260.00**	$ 0	
TOTAL OF ABOVE CALCULATIONS =				$	
Reduction of 1/2 for filing by small entity, if applicable. A Small Entity Statement must also by filed (Note 37 CFR 1.9, 1.27, 1.28).				$	
SUBTOTAL =				$	
Processing fee of **$130.00** for furnishing the English translation later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +				$	
TOTAL NATIONAL FEE =				$	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$ 40	
TOTAL FEES ENCLOSED =				$ 900	
				Amount to be refunded:	$
				charged:	$

a. [X] A check in the amount of $ 900 to cover the above fees is enclosed.

b. [ ] Please charge my Deposit Account No. ______ in the amount of $______ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. [X] The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 22-0493. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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NAME

34,626

REGISTRATION NUMBER

09/763980

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INA-PT049 (3284-18-US)

APPLICATION DATA SHEET
UNDER 37 CFR §1.76

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(3) Application Information

Title Line::	IFFERENTIAL FOR A MOTOR VEHICLE
Total Drawing Sheets::	2
Drawing Type::	Formal
Application Type::	Utility
Docket No.::	INA-PT049 (3284-18-US)

(4) Representative Information

Representative Customer No.:: 3624

(5) Domestic Priority Information

This application is a::	371 National Phase of
>Application One::	PCT/EP99/05885
Filing Date::	8/11/1999

(6) Foreign Priority Information

Foreign Application One::	198 39 481.0
Filing Date::	8/29/1998
Country::	Germany
Priority Claimed::	YES

09/763980

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INA-PT049
(3284-18-US)

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SUBSTITUTE SPECIFICATION

[0001] DIFFERENTIAL FOR A MOTOR VEHICLE

[0002] AREA OF APPLICATION OF THE INVENTION

[0003 The present invention concerns a transfer case or differential with a bevel-pinion shaft which is supported in a drive housing by two spaced and axially pretensioned angular-contact ball bearings and which drives via a bevel pinion and ring gear a differential unit mounted in the drive housing, axle shafts being supported in the differential unit which are operationally connected with each other via output and differential gears.

[0004] BACKGROUND

[0005] Such differential gear boxes permit the drive wheels of each axle shaft to roll in slip-free fashion at a different speed of rotation in travelling over a curved path. A bevel-pinion shaft or a drive shaft with a bevel gear drives a ring gear rotationally joined with the differential unit in the interior of which are mounted output and differential gears. While driving straight ahead, these differential gears in the differential unit are at rest so that both axle shafts turn at the same speed of rotation as the ring gear. Upon driving in a curved path, a difference occurs in the speed of rotation of the two axle shafts. In this case, the differential gears rotate and result in the fact that the increase in the speed of rotation of the one axle shaft compared to the speed of rotation of the ring gear is precisely as large as the decrease in the speed of rotation of the other axle shaft compared to the ring gear.

[0006] Such a generic differential gear box is described, for example, in the handbook "Roller Bearings -- Computation and Design" by W. Hampp, Springer-Verlag Berlin/Heidelberg/New York in Figure 88. The bevel pinion shaft is supported in this case via two spaced conical-roller bearings pretensioned in the axial direction. The

pretensioning occurs as a result of the conical-roller bearings being moved toward each other in the axial direction via a threaded connection.

[0007] Disadvantageous here is that fact that due to the pretensioning of the conical-roller bearings, sliding friction develops between the end walls of the conical rollers and the edge surface of the bearing rings, which leads to wear of the conical rollers and edge surfaces. This wear, in turn, is responsible for loss in pretensioning of the bearing, as a result of which there occurs an increase in tooth play between the bevel pinion and the ring gear, with its negative consequences.

[0008] In connection with this, a differential gear box is known from U.S. Patent No. 3,792,625, whose bevel-pinion shaft is supported by two spaced apart angular contact ball bearings. Such a bearing arrangement however does not meet the requirements for high performance drives and was therefore not useable from a technical standpoint. For one, the carrier teeth and also the rigidity are too small. Therefore it results in an uneven carrier stopping that lowers the service life of the drive and generates noise when the teeth of the bevel-pinion shaft and the ring gear mesh.

[0009] SUMMARY

[0010] The present invention is therefore directed to developing an improved bearing arrangement for the bevel-pinion shaft of a differential.

[0011] According to the present invention, this problem is solved in line with the characterizing portion of Claim 1 through the fact that the angular contact ball bearings are designed as unilaterally loadable double-row tandem angular-contact ball bearings, which each include a one piece inner bearing race and a one piece over bearing race and which face each other in an O-arrangement.

[0012] The advantages of the solution of the present invention compared to the classical solution with conical-roller bearings are the following:

[0013] Due to the substantially reduced frictional moment based on the lack of sliding friction in the bearing arrangement of the present invention, there necessarily also result reduced bearing temperatures and accordingly also a reduced oil-sump temperature. Thus, overall, better efficiency and a lower power loss of the bearing arrangement are attained. Upon installation of the bearing arrangement of the present invention in a motor vehicle, reduced fuel consumption is now possible as a result of the lower power loss. The approximately 40°C lower temperatures of the oil sump also make it possible that a lighter housing material, for example, a magnesium alloy can be employed for the differential housing which, in turn, makes itself felt in a saving of weight.

[0014] A further advantage is a reduced wear of the bearing, which amounts to only about 1/10 of the wear for the classical solution. This reduced wear accounts for the avoidance of axial shifting of the bevel-pinion shaft along with the known negative increase in tooth play between the bevel pinion on the bevel-pinion shaft and the ring gear connected with the differential unit.

[0015] Further advantageous refinements of the solution of the present invention are described in dependent claims 2-6. Thus, according to Claims 2 and 3, one provides that the races of a bearing exhibit respectively the same or a different diameter and the same or a different pressure angle.

[0016] According to a further feature relating to Claim 4, the bearing balls of both races of a bearing are guided in cages and have the same or a different diameter.

[0017] It is clear from Claim 5 that the first double-row tandem angular-contact ball bearing positioned next to the bevel pinion on the bevel-pinion shaft is larger than the accompanying second bearing. This appropriate refinement is undertaken because the greatest loads both in the radial as well as in the axial direction need to be accommodated in the immediate vicinity of the bevel pinion.

[0018] Finally, it is clear from Claim 6 that the inner ring of the second double-row tandem angular-contact ball bearing is supported in the axial direction against a

deformable sleeve. After adjustment for the desired pretensioning, this sleeve provides for the fact that the adjustment screw is likewise put under pretensioning through the action of a counter force. Spontaneous loosening of this threaded screw is therefore not possible.

[0019] The present invention is described in more detail on the basis of the following preferred embodiment.

[0020] BRIEF DESCRIPTION OF THE DRAWINGS

[0021] Figure 1 is a cross-section through a differential of a motor vehicle according to the prior art,

[0022] Figure 2 is a longitudinal cross-section through a bevel-pinion shaft with the bearing arrangement of the present invention.

[0023] DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0024] The motor-vehicle differential shown in Figure 1 includes a housing 1 in which a differential unit 2 is supported via two conical-roller bearings 3. A bevel pinion 4 on a bevel-pinion shaft 5 drives a ring gear 6, which, in turn, sets the differential unit 2 in motion. The differential unit 2 is connected via differential gears 7 and output gears 8 with each of the axle shafts 9, which drive unshown wheels. The bevel-pinion shaft 5 is likewise held in housing 1 via two additional spaced apart conical-roller bearings 10, which are moved toward each other in the axial direction by a threaded piece 11, i.e., put under pretensioning.

[0025] The inner rings 12 of conical-roller bearings 10 are provided with a radially outwardly directed edge 13 against which the end wall of conical rollers 14 run. Through the pretensioned conical-roller bearings 10, sliding friction develops between the end walls of conical rollers 14 and the inner surface of edge 13, which leads to wear through removal of material and has a negative effect on the final drive, i.e., such support of the bevel-pinion shaft 5 according to the state of the art involves a high frictional moment, high bearing and oil temperatures, as well as poor efficiency. In addition, the loss in

pretensioning developing as a result of the wear of the conical rollers and edge surfaces leads to an increase in tooth play between bevel pinion 4 and ring gear 6.

[0026] The bevel-pinion shaft 5 of a differential shown in Figure 2 includes a stepped shank 15 on whose right-side end lies bevel pinion 4. In housing 1, the bevel-pinion shaft 5 is held by two spaced-apart tandem angular-contact ball bearings 16 and 17 which each include a one-piece bearing inner ring 18 and a one-piece bearing outer ring 19, with each ring having two shoulders 20 and 21. The bearing balls 22 and 23 are of the same size within bearings 16 and 17 and are guided in each case in bearing cages 24. One can further see from the figure that within a given bearing 16 and 17, the not more closely designated races of bearing balls 22 and 23 possess a different diameter. Since the greatest radial and axial stressing of bevel-pinion shaft 5 occurs in the area of bevel pinion 4, tandem angular-contact ball bearing 16 is substantially larger than tandem angular-contact ball bearing 17. As a result of the O-arrangement of the two tandem angular-contact ball bearings 16 and 17 with respect to each other, one ensures that one of bearings 16,17 can accommodate any force in an axial direction, i.e., axial shifting of the bevel-pinion shaft 5 is not possible. The pretensioning is produced in known fashion as a result of the fact that bevel pinion 4 is moved in the direction of housing 1, i.e., axially toward the left by screwing threaded piece 11 onto shank 15 of bevel-pinion shaft 5 so that both bearings 16,17 are put under pretensioning. A sleeve 25 is positioned between bearings 16 and 17 on trunk 15 of bevel-pinion shaft 5. This sleeve is supported, on the one hand, on inner ring 18 of bearing 17 and, on the other hand, on an undesignated step of shank 15. Upon tightening threaded piece 11, the bearing inner ring 18 of bearing 17 is first shifted toward the right so that a deformation force is exerted on sleeve 25, i.e., the latter becomes deformed. As a result of this deformation, however, a counter force is exerted by sleeve 25 on the inner ring 18 of bearing 17 so that threaded piece 11 is loaded with this counter force and can consequently not undergo spontaneous loosening from the threading of the shank 15 of bevel-pinion shaft 5.

[0027] In contrast to the classical support of bevel-pinion shaft 5 with conical-roller bearings 10, only rolling friction is present, and even with relatively strong pretensioning, i.e., wear is very greatly reduced.

Element Numbers

1 housing

2 differential unit

3 conical-roller bearing

4 bevel pinion

5 bevel-pinion shaft

6 ring gear

7 differential gear

8 output gear

9 axle shaft

10 conical-roller bearing

11 threaded piece

12 inner ring

13 edge

14 conical roller

15 shank

16 tandem angular-contact ball bearing

17 tandem angular-contact ball bearing

18 inner ring

19 outer ring

20 shoulder

21 shoulder

22 bearing ball

23 bearing ball

24 cage

25 sleeve

* * *

CLAIMS

What is claimed is:

1. Differential for a motor vehicle with a bevel-pinion shaft (5) which is supported in a drive housing (1) by two spaced and axially pretensioned angular-connect ball bearings and which, through a bevel pinion (4) and a ring gear (6), drives a differential unit (2) mounted in the drive housing (1), axle shafts (9) being supported in the differential unit (2) which are operationally connected with each other via output gears (8) and differential gears (7), **characterized in** that the angular-contact ball bearings are designed as unilaterally loadable double-row tandem angular-contact ball bearings (16,17) which each include a one piece inner bearing race (18) and a one piece outer bearing race (19) and which face each other in an O-arrangement.

2. Differential according to Claim 1, characterized in that the races of the bearings (16,17) have the same or a different diameter.

3. Differential according to Claim 1, characterized in that the races of that bearings (16,17) have the same or a different pressure angle.

4. Differential according to Claim 1, characterized in that the bearing balls (22,23) of both races of the bearings (16,17) are guided in cages (24) and have the same or a different diameter.

5. Differential according to Claim 1, characterized in that the first tandem angular-contact ball bearing (16) positioned next to the bevel pinion (4) of the bevel-pinion shaft (5) is larger than the second bearing (17).

6. Differntial according to Claim 1, characterized in that the inner ring (18) of the second double-row tandem angular-contact ball bearing (17) is supported in an axial direction against a deformable sleeve (25).

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(3284-18-US)

ABSTRACT

A bevel-pinion shaft (5) of a differential of a motor vehicle is supported in a housing (1) by two spaced unilaterally loadable double-row tandem angular-contact ball bearings (16,17) which face each other in an O-arrangement. Compared to the classical support by conical-roller bearings, a substantially lower frictional moment and substantially lower bearing wear are attained by the bearing arrangement of the present invention.

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INA-PT049
(3284-18-US)

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TRANSLATION OF INTERNATIONAL APPLICATION NO. PCT/EP99/05885

[0001] DIFFERNTIAL FOR A MOTOR VEHICLE

[0002] AREA OF APPLICATION OF THE INVENTION

[0003] The present invention concerns a transfer case or differential with a bevel-pinion shaft which is supported in a drive housing by two spaced and axially pretensioned roller bearings and which drives via a bevel pinion and ring gear a differential unit mounted in the drive housing, axle shafts being supported in the differential unit which are operationally connected with each other via output and differential gears.

[0004] BACKGROUND

[0005] Such differential gear boxes permit the drive wheels of each axle shaft to roll in slip-free fashion at a different speed of rotation in travelling over a curved path. A bevel-pinion shaft or a drive shaft with a bevel gear drives a ring gear rotationally joined with the differential unit in the interior of which are mounted output and differential gears. While driving straight ahead, these differential gears in the differential unit are at rest so that both axle shafts turn at the same speed of rotation as the ring gear. Upon driving in a curved path, a difference occurs in the speed of rotation of the two axle shafts. In this case, the differential gears rotate and result in the fact that the increase in the speed of rotation of the one axle shaft compared to the speed of rotation of the ring gear is precisely as large as the decrease in the speed of rotation of the other axle shaft compared to the ring gear.

[0006] Such a generic differential gear box is described, for example, in the handbook "Roller Bearings -- Computation and Design" by W. Hampp, Springer-Verlag Berlin/Heidelberg/New York in Figure 88. The bevel pinion shaft is supported in this

case via two spaced conical-roller bearings pretensioned in the axial direction. The pretensioning occurs as a result of the conical-roller bearings being moved toward each other in the axial direction via a threaded connection.

[0007] Disadvantageous here is that fact that due to the pretensioning of the conical-roller bearings, sliding friction develops between the end walls of the conical rollers and the edge surface of the bearing rings, which leads to wear of the conical rollers and edge surfaces. This wear, in turn, is responsible for loss in pretensioning of the bearing, as a result of which there occurs an increase in tooth play between the bevel pinion and the ring gear, with its negative consequences.

[0008] SUMMARY

[0009] The present invention is therefore directed to developing an improved bearing arrangement for the bevel-pinion shaft of a differential.

[0010] According to the present invention, this problem is solved with the characterizing portion of Claim 1 through the fact that the roller bearings are designed as unilaterally loadable double-row tandem angular-contact ball bearings which face each other in an O-arrangement.

[0011] The advantages of the solution of the present invention compared to the classical solution with conical-roller bearings are the following:

[0012] Due to the substantially reduced frictional moment based on the lack of sliding friction in the bearing arrangement of the present invention, there necessarily also result reduced bearing temperatures and accordingly also a reduced oil-sump temperature. Thus, overall, better efficiency and a lower power loss of the bearing arrangement are attained. Upon installation of the bearing arrangement of the present invention in a motor vehicle, reduced fuel consumption is now possible as a result of the lower power loss. The approximately 40°C lower temperatures of the oil sump also make it possible

that a lighter housing material, for example, a magnesium alloy can be employed for the differential housing which, in turn, makes itself felt in a saving of weight.

[0013] A further advantage is a reduced wear of the bearing, which amounts to only about 1/10 of the wear for the classical solution. This reduced wear accounts for the avoidance of axial shifting of the bevel-pinion shaft along with the known negative increase in tooth play between the bevel pinion on the bevel-pinion shaft and the ring gear connected with the differential unit.

[0014] Further advantageous refinements of the solution of the present invention are described in dependent claims 2-6. Thus, according to Claims 2 and 3, one provides that the races of a bearing exhibit respectively the same or a different diameter and the same or a different pressure angle.

[0015] According to a further feature relating to Claim 4, the bearing balls of both races of a bearing are guided in cages and have the same or a different diameter.

[0016] It is clear from Claim 5 that the first double-row tandem angular-contact ball bearing positioned next to the bevel pinion on the bevel-pinion shaft is larger than the accompanying second bearing. This appropriate refinement is undertaken because the greatest loads both in the radial as well as in the axial direction need to be accommodated in the immediate vicinity of the bevel pinion.

[0017] Finally, it is clear from Claim 6 that the inner ring of the second double-row tandem angular-contact ball bearing is supported in the axial direction against a deformable sleeve. After adjustment for the desired pretensioning, this sleeve provides for the fact that the adjustment screw is likewise put under pretensioning through the action of a counter force. Spontaneous loosening of this threaded screw is therefore not possible.

[0018] According to the second independent Claim 7, the problem of the present invention is also solved through the fact that the roller bearings are each designed as two

unilaterally loadable single-unit angular-contact ball bearings in tandem arrangement, with the bearings facing each other in an O-arrangement.

[0019] The present invention is described in more detail on the basis of the following preferred embodiment.

[0020] BRIEF DESCRIPTION OF THE DRAWINGS

[0021] Figure 1 is a cross-section through a differential of a motor vehicle according to the prior art,

[0022] Figure 2 is a longitudinal cross-section through a bevel-pinion shaft with the bearing arrangement of the present invention.

[0023] DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0024] The motor-vehicle differential shown in Figure 1 includes a housing 1 in which a differential unit 2 is supported via two conical-roller bearings 3. A bevel pinion 4 on a bevel-pinion shaft 5 drives a ring gear 6, which, in turn, sets the differential unit 2 in motion. The differential unit 2 is connected via differential gears 7 and output gears 8 with each of the axle shafts 9, which drive unshown wheels. The bevel-pinion shaft 5 is likewise held in housing 1 via two additional spaced-apart conical-roller bearings 10, which are moved toward each other in the axial direction by a threaded piece 11, i.e., put under pretensioning.

[0025] The inner rings 12 of conical-roller bearings 10 are provided with a radially outwardly directed edge 13 against which the end wall of conical rollers 14 run. Through the pretensioned conical-roller bearings 10, sliding friction develops between the end walls of conical rollers 14 and the inner surface of edge 13, which leads to wear through removal of material and has a negative effect on the final drive, i.e., such support of the bevel-pinion shaft 5 according to the state of the art involves a high frictional moment, high bearing and oil temperatures, as well as poor efficiency. In addition, the loss in

pretensioning developing as a result of the wear of the conical rollers and edge surfaces leads to an increase in tooth play between bevel pinion 4 and ring gear 6.

[0026] The bevel-pinion shaft 5 of a differential shown in Figure 2 includes a stepped shank 15 on whose right-side end lies bevel pinion 4. In housing 1, the bevel-pinion shaft 5 is held by two spaced-apart tandem angular-contact ball bearings 16 and 17 which each include a one-piece bearing inner ring 18 and a one-piece bearing outer ring 19, with each ring having two shoulders 20 and 21. The bearing balls 22 and 23 are of the same size within bearings 16 and 17 and are guided in each case in bearing cages 24. One can further see from the figure that within a given bearing 16 and 17, the not more closely designated races of bearing balls 22 and 23 possess a different diameter. Since the greatest radial and axial stressing of bevel-pinion shaft 5 occurs in the area of bevel pinion 4, tandem angular-contact ball bearing 16 is substantially larger than tandem angular-contact ball bearing 17. As a result of the O-arrangement of the two tandem angular-contact ball bearings 16 and 17 with respect to each other, one ensures that one of bearings 16,17 can accommodate any force in an axial direction, i.e., axial shifting of the bevel-pinion shaft 5 is not possible. The pretensioning is produced in known fashion as a result of the fact that bevel pinion 4 is moved in the direction of housing 1, i.e., axially toward the left by screwing threaded piece 11 onto shank 15 of bevel-pinion shaft 5 so that both bearings 16,17 are put under pretensioning. A sleeve 25 is positioned between bearings 16 and 17 on trunk 15 of bevel-pinion shaft 5. This sleeve is supported, on the one hand, on inner ring 18 of bearing 17 and, on the other hand, on an undesignated step of shank 15. Upon tightening threaded piece 11, the bearing inner ring 18 of bearing 17 is first shifted toward the right so that a deformation force is exerted on sleeve 25, i.e., the latter becomes deformed. As a result of this deformation, however, a counter force is exerted by sleeve 25 on the inner ring 18 of bearing 17 so that threaded piece 11 is loaded with this counter force and can consequently not undergo spontaneous loosening from the threading of the shank 15 of bevel-pinion shaft 5.

[0027] In contrast to the classical support of bevel-pinion shaft 5 with conical-roller bearings 10, only rolling friction is present, and even with relatively strong pretensioning, i.e., wear is very greatly reduced.

Element Numbers

1 housing

2 differential unit

3 conical-roller bearing

4 bevel pinion

5 bevel-pinion shaft

6 ring gear

7 differential gear

8 output gear

9 axle shaft

10 conical-roller bearing

11 threaded piece

12 inner ring

13 edge

14 conical roller

15 shank

16 tandem angular-contact ball bearing

17 tandem angular-contact ball bearing

18 inner ring

19 outer ring

20 shoulder

21 shoulder

22 bearing ball

23 bearing ball

24 cage

25 sleeve

* * *

CLAIMS

What is claimed is:

1. Differential for a motor vehicle with a bevel-pinion shaft (5) which is supported in a drive housing (1) by two spaced and axially pretensioned roller bearings and which, through a bevel pinion (4) and a ring gear (6), drives a differential unit (2) mounted in the drive housing (1), axle shafts (9) being supported in the differential unit (2) which are operationally connected with each other via output gears (8) and differential gears (7), **characterized in** that the roller bearings are designed as unilaterally loadable double-row tandem angular-contact ball bearings (16,17) which face each other in an O-arrangement.

2. Differential drive according to Claim 1, characterized in that the races of the bearings (16,17) have the same or a different diameter.

3. Differential according to Claim 1, characterized in that the races of the bearings (16,17) have the same or a different pressure angle.

4. Differential according to Claim 1, characterized in that the bearing balls (22,23) of both races of the bearings (16,17) are guided in cages (24) and have the same or a different diameter.

5. Differential according to Claim 1, characterized in that the first tandem angular-contact ball bearing (16) positioned next to the bevel pinion (4) of the bevel-pinion shaft (5) is larger than the second bearing (17).

6. Differential according to Claim 1, characterized in that the inner ring (18) of the second double-row tandem angular-contact ball bearing (17) is supported in an axial direction against a deformable sleeve (25).

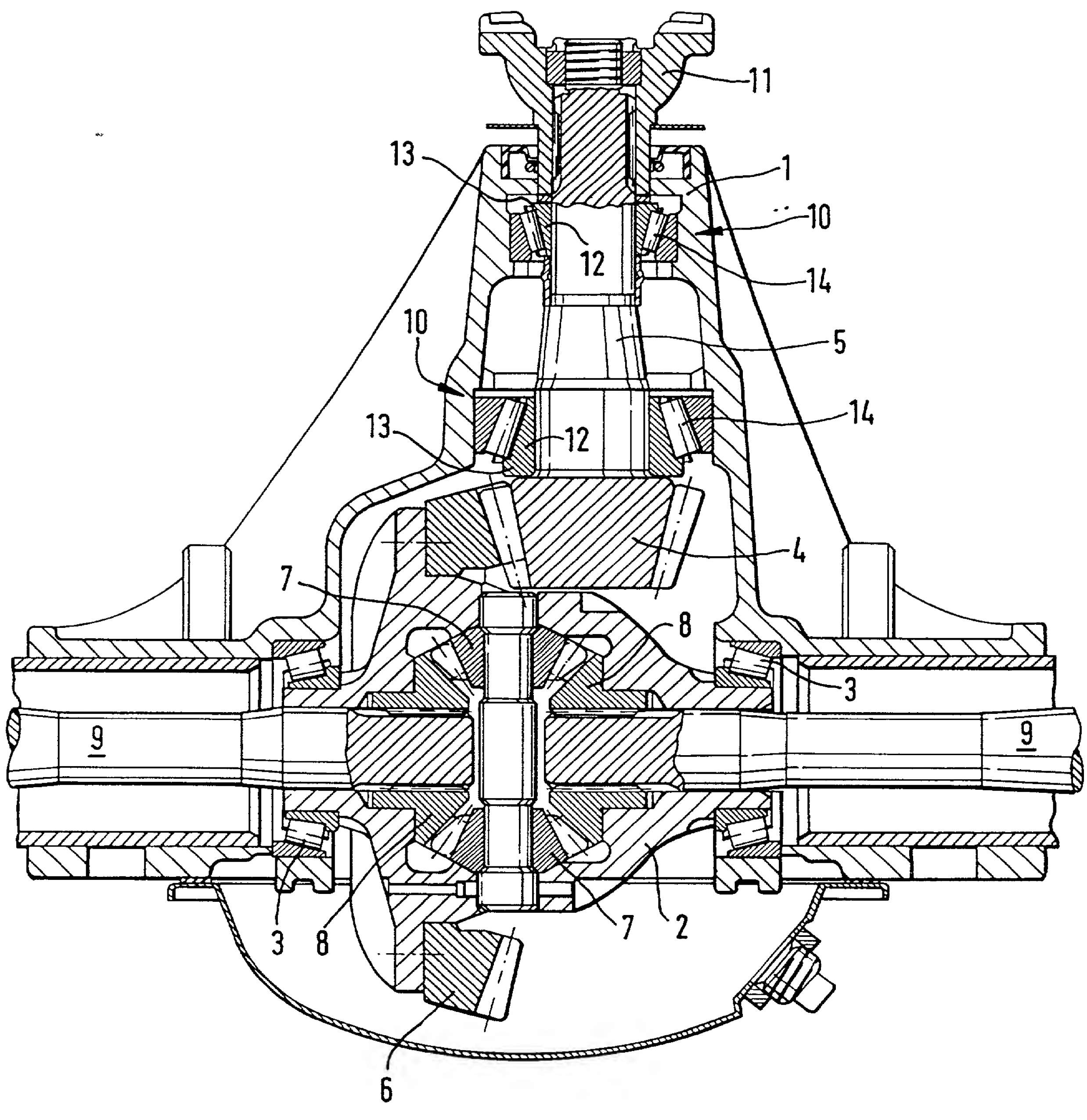
7. Differential according to the introductory phrase of Claim 1, characterized in that the antifriction bearings are each designed as two unilaterally loadable single-unit angular-contact ball bearings in a tandem arrangement that face each other in an O-arrangement.

INA-PT049
(3284-18-US)

ABSTRACT

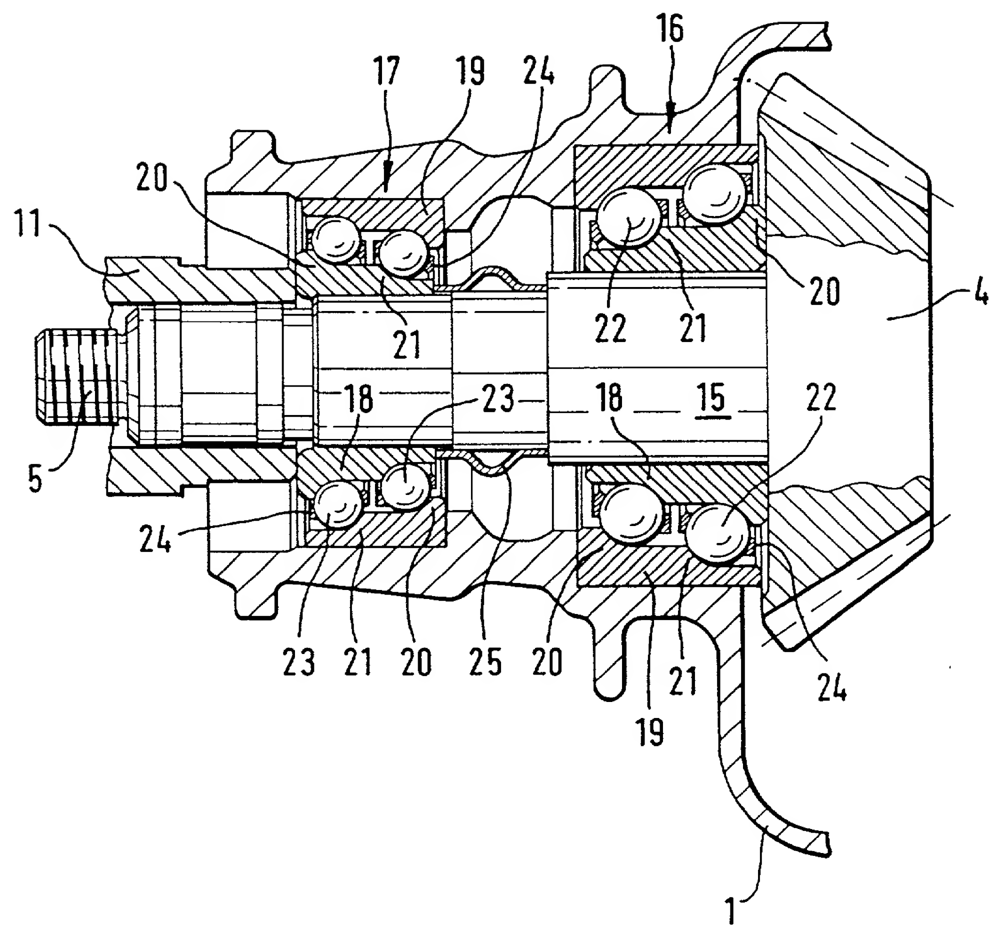
A bevel-pinion shaft (5) of a differential of a motor vehicle is supported in a housing (1) by two spaced unilaterally loadable double-row tandem angular-contact ball bearings (16,17) which face each other in an O-arrangement. Compared to the classical support by conical-roller bearings, a substantially lower frictional moment and substantially lower bearing wear are attained by the bearing arrangement of the present invention.

Fig. 1



09/763980

Fig. 2



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DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63)

☐ Declaration Submitted with Initial Filing **OR** ☒ Declaration Submitted after Initial Filing (surcharge (37 CFR 1.16 (e)) required)

Attorney Docket Number	INA-PT049 (3284-18-US)
First Named Inventor	Jacob et al.
COMPLETE IF KNOWN	
Application Number	09/763,980
Filing Date	2/28/01
Group Art Unit	Not Yet Known
Examiner Name	Not Yet Known

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

DIFFERENTIAL FOR A MOTOR VEHICLE

(Title of the Invention)

the specification of which

☐ is attached hereto

OR

☒ was filed on (MM/DD/YYYY) 08/11/1999 as United States Application Number or PCT International Application Number PCT/EP99/05885 and was amended on (MM/DD/YYYY) 07/12/2000 (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached? YES	NO
198 39 481.0	Germany	08/29/1998	☐	☐	☐
			☐	☐	☐
			☐	☐	☐
			☐	☐	☐

☐ Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto:

I hereby claim the benefit under 35 U.S.C. 119(e) of any United States provisional application(s) listed below.

Application Number(s)	Filing Date (MM/DD/YYYY)

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DECLARATION — Utility or Design Patent Application

I hereby claim the benefit under 35 U.S.C. 120 of any United States application(s), or 365(c) of any PCT international application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

U.S. Parent Application or PCT Parent Number	Parent Filing Date (MM/DD/YYYY)	Parent Patent Number *(if applicable)*
PCT/EP99/05885	08/11/1999	

☐ Additional U.S. or PCT international application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

As a named inventor, I hereby appoint the following registered practitioner(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith: ☒ Customer Number 3624 → *Place Customer Number Bar Code Label here*
OR
☐ Registered practitioner(s) name/registration number listed below

Name	Registration Number	Name	Registration Number
Namely, the Attorneys of Volpe and Koenig, P.C.			

☐ Additional registered practitioner(s) named on supplemental Registered Practitioner Information sheet PTO/SB/02C attached hereto.

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Country		Telephone		Fax	

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Name of Sole or First Inventor: ☐ A petition has been filed for this unsigned inventor

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☒ Additional inventors are being named on the 1 supplemental Additional Inventor(s) sheet(s) PTO/SB/02A attached hereto

1-50

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DECLARATION

ADDITIONAL INVENTOR(S)
Supplemental Sheet
Page 3 of 3

2-00

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Inventor's Signature						Date	
Residence: City		State		Country		Citizenship	
Post Office Address							
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City		State		ZIP		Country	

Name of Additional Joint Inventor, if any:		☐ A petition has been filed for this unsigned inventor					
Given Name (first and middle [if any])		Family Name or Surname					
Inventor's Signature						Date	
Residence: City		State		Country		Citizenship	
Post Office Address							
Post Office Address							
City		State		ZIP		Country	